The Incidence of Sudden Infant Death Syndrome In North Carolina's Cities and Counties: 1972–1974*

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Abstract: Between January 1, 1972 and December 31, 1974, 534 Sudden Infant Death Syndrome cases were reported in North Carolina. All but the out-of-state cases were mapped by county and city locations to determine if urban or rural cases predominated. The mapping was also undertaken to see if significant spatial variabilities could be detected between the county and city populations of infants at risk. The state had an overall SIDS rate of 2.06 per thousand live births. The mapping revealed that counties had a range from zero to a high of 6.6 and that cities with populations of over 10,000 had SIDS rates which ranged from zero to a high of 10.6. The proportions of SIDS cases occurring in either urban or rural locations roughly approximated the distribution of the state's population, with neither location accounting for disproportionately more cases. The larger cities, however, reported more cases than did their suburbs and the immediately surrounding rural areas. The largest and smallest cities, when grouped accordingly, had the lowest urban SIDS rates. The summary SIDS rates for whites was 1.23 per thousand live births, for blacks it was 3.75, and for Indians it was 6.56 per thousand live births. (Am. J. Public Health 68:367–372, 1978)

Introduction

With few exceptions, studies focusing upon the locational attributes of Sudden Infant Death Syndrome (SIDS) cases in the United States have been confined to a number of major metropolitan areas. The basic reason for this is that reliable data on the incidence of SIDS for entire states are lacking for most of the country. Because of this, questions have been raised as to whether the SIDS rates reported for large urban areas differ significantly from those or rural areas of from those of smaller cities.[1] It has also been asked whether the incidence of SIDS differs significantly between upper or middle class rural settlements and those of Appalachia.[2] With the availability of SIDS data by cities and counties in North Carolina some of these questions may be answered. Over a three-year period beginning on January 1, 1972 and ending on December 31, 1974, some 534 SIDS cases were reported in North Carolina (Table 1).

North Carolina is a diverse state possessing five highly urbanized counties which are dominated by cities with populations of well over 100,000 people. At the other extreme, the state also has some 34 counties which were classed as being exclusively rural by the 1970 Census of Population. In 1974, the nonwhite population was 22.5 per cent of the total. The preponderance of the nonwhite population is black, but there are also several western counties with minority populations of Cherokee Indians and there is a grouping of counties in the southern coastal plain area of the state which contain substantial numbers of Lumbee Indians.

Methods of Study

An attempt was made to map all of the 534 SIDS cases reported during the three-year period studied according to whether they occurred in either urban or rural locations in each of the state's 100 counties. On the basis of this mapping and the utilization of live birth denominator data, white, nonwhite, and combined SIDS incidence rates per thousand live births were calculated for all the counties in the state. Separate SIDS incidence rates were also calculated for all of the state's cities which had populations of over 10,000 people. All but six of the cases were mapped, and these were infants from out-of-state. The out-of-state cases were not used in the calculation of county rates, but they were included in the calculation of state rates.

The county SIDS rates and the city SIDS rates were

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*Through the courtesy of R. Page Hudson, Jr., the North Carolina Chief Medical Examiner, data have been made available to the author on the age, race, sex, date of death, county of death, and the places of residence for all of the confirmed SIDS cases that have occurred in the state since January, 1972.

Others who have contributed much of their time and have provided data for this study are: Neil A. Hoffman, Associate Chief Medical Examiner, who reviewed all of the SIDS cases which occurred during the period studied, (1972–1974), and Ruth Ann Yauger, the North Carolina SIDS Project Coordinator, who provided information on the socioeconomic circumstances of SIDS families.

TABLE 1—Number of SIDS Cases and Rates per 1,000 Live Births for 1972-1974, North Carolina

	1972		1973		1974		Total	
	N	Rate*	N	Rate*	N	Rate*	N	Rate*
White Male	46	1.45	43	1.41	46	1.53	135	1.46
White Female	26	.90	34	1.2	25	0.9	85	0.99
Total White	72	1.17	77	1.31	71	1.23	220	1.23
Black Male	55	4.21	57	4.51	56	4.44	168	4.4
Black Female	46	3.63	34	2.72	32	2.97	112	3.1
Total Black	101	3.92	91	3.62	92	3.72	284	3.75
Indian Male	7	8.3	4	5.17	3	3.61	14	5.71
Indian Female	4	5.4	6	7.49	3	3.87	13	5.60
Total Indian	11	6.9	10	6.4	6	3.73	27	6.56
Total Male	108	2.4	105	2.4	105	2.42	318	2.4
Total Female	76	1.8	74	1.8	66	1.62	216	1.72
All Cases	184	2.1	179	2.1	171	2.03	534	2.06

*per 1,000 live births

TABLE 2—SIDS Cases Per Year and the Proportion of All Cases Autopsied*

	1972	1973	1974	Total
Number of SIDS Cases	184	179	171	534
Percentage of SIDS Cases Autopsied	77%	83%	89%	83%**

*Approximately 50 per cent of the autopsies performed were done at the Central Office of the Chief Medical Examiner.

**Approximately 17 per cent of the SIDS cases in this study were not autopsied. These cases were counted as SIDS events by the reviewing pathologists at the Chief Medical Examiner's Office when the infants were less than one year of age, and the death was sudden and unexpected.

both mapped separately to see if any conspicuous patterns could be detected indicating the presence either of unusual clusterings of cases in some areas or the absences of cases in others.

Counties exhibiting similarities in the levels of urban development were grouped and SIDS rates were calculated for each of the different groupings. The state's cities were grouped into six consecutive size classes and urban SIDS rates were calculated for each size class. Finally, the observed city and county SIDS rates were correlated with the general infant mortality rates to determine if areas having consistently higher infant mortality rates also had noticeably higher SIDS rates.

SIDS Case Ascertainment in North Carolina

The Office of the Chief Medical Examiner in North Carolina, through a state-wide system of certified Regional Pathologists and licensed County Medical Examiners, has been making a concerted effort to document every SIDS case that occurs in the state.

In addition to the SIDS cases confirmed by autopsy, the pathologists at the Chief Medical Examiner's Office have also included a substantial number of cases in the total for which autopsies were not performed for some unknown reason. SIDS is sometimes listed as the cause of death on death certificates, even though autopsies were not performed. Very rarely, the listing of such causes of death as "suffocation" or "aspiration" arouses sufficient suspicion to warrant follow-up investigations. In all cases where SIDS was listed as a cause of death on death certificates without the benefit of autopsy findings, cases were re-investigated to confirm that infants were less than one year of age and that they were apparently in good health before succumbing suddenly and unexpectedly. The proportion of the SIDS cases reported annually that were autopsied have been increasing steadily in North Carolina (see Table 2).

It is the custom and it is required by statute that each death of unknown cause be reported to a physician County Medical Examiner, who is appointed by the Chief Medical Examiner. The sudden death of an otherwise healthy infant automatically involves the County Medical Examiner who upon investigation of the case determines if the death is within his jurisdiction as specified by the governing statute and by the Rules and Regulations of the Medical Examiner System. The state statute directs the County Medical Examiner to order autopsies when it is in the public interest. The Rules and Regulations and the Guidelines of the Office of the Chief Medical Examiner provide that all sudden unexpected deaths of infants (potential SIDS events) be autopsied. The body intended for autopsy is transported to a certified Regional Pathologist, who is designated by the Chief Medical Examiner, or to the Central Office of the State Medical Examiner System for performance of the autopsy. If the pathologist determines the cause and manner of death upon gross autopsy, he notifies the County Medical Examiner by telephone of his findings. If no cause of death is found the Regional Pathologist or County Medical Examiner notifies the Central Office that an apparent SIDS death has occurred and supplies information including the child's name, names of parents, their addresses, and the like.

Approximately one-half of all the autopsies of infants who died suddenly and unexpectedly are done at the Central Office by the forensic pathologists of the Chief Medical Examiner's staff. In all of these cases a common autopsy protocol is adhered to. Additional autopsy studies such as microscopic, toxicology, bacteriology, and the like reveal findings that death was due to some specific infectious agent or toxin in approximately ten per cent of the grossly negative autopsies. Both the gross and microscopic findings of all the autopsies performed by the Regional Pathologists are also reviewed or re-investigated by one or more of the forensic pathologists of the Chief Medical Examiner's Staff before these cases are counted as having been SIDS events (Table 2).

The total number of reported SIDS cases may be affected by either a slight under-reporting or by the counting of some sudden and unexplained deaths of infants for which autopsy studies would reveal other causes of death. Even if either circumstance predominated, the change in the total number of reported cases is not believed to be so large as to have drastically altered the race or sex specific SIDS rates that were calculated for the entire state. The rates of a number of cities or counties, on the other hand, would be altered significantly if one or several cases were added to those already counted. It is likely that both circumstances prevail to

a minor extent with the result that the effect of any under-reporting would be offset by the effect of any miss-identification of cases.

Birth Registration in North Carolina

The live birth denominator data used throughout this study in the calculation of city, county, and multi-county SIDS rates are taken from the annual vital statistics reports published by the Division of Health Services of the Department of Human Resources. The flow of live birth data begins with the filing of birth certificates, which is required by statute of physicians, midwives, or other persons attending births. The clerks of the county health departments forward the original certificates to the Department of Human Resources. Tests conducted in 1940, and again in 1950, to check the completeness of birth registration procedure in North Carolina, revealed that the registrations were 86 and 96 per cent complete respectively.[3] In 1974, 99.6 per cent of the resident live births were attended by physicians in the state, and 99.1 per cent of the births took place in hospitals.[4] The registration of live births to North Carolina residents which occurred outside the state is sometimes delayed and may not reach the Division of Health Services until after the statistical file is closed for publication. The number of such cases is small and in each of the years covered by this study 99.9 per cent of the births were registered within the reporting period.[5]

Combined White and Nonwhite SIDS Rates by Counties

Over the three-year period, 19 counties did not report a single SIDS case and 27 counties reported only one or two cases. The calculation of county SIDS rates based on just one or two reported cases in some instances yielded rates that were considerably above the average state rate, and this was the case in several western counties of the state. For most of the 27 counties that reported so few cases, the SIDS rates were relatively close to the state average. For all the counties, the SIDS rates ranged from zero to a high of 6.6 per thousand live births (Figure 1).

The mapping of SIDS rates by counties did not reveal that counties with like SIDS rates were arranged into any readily recognizable groupings. After some observation, however, taking into account the racial composition of counties and some generalized geographical subidivisions of the state, it was possible to detect slight subregional differences in SIDS rates which needed explanation.

The 25 western counties comprise the Appalachian Mountains subregion of the state. Of these counties, nine did not report a single SIDS case during the three years and ten others had SIDS rates that were below the average state rate. The Appalachian Mountain counties collectively had a SIDS rate of 1.4 per thousand live births, which was considerably below the state average of 2.06 per thousand live

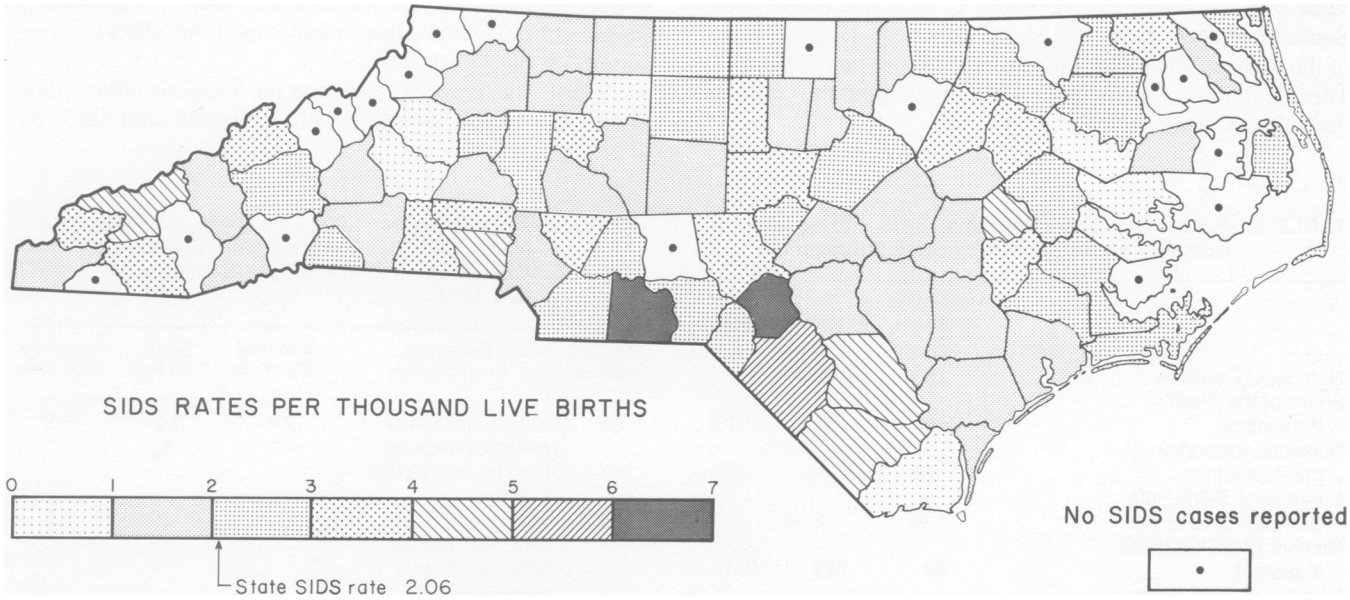

FIGURE 1—County SIDS rates in North Carolina, three-year summary: 1972, 1973, and 1974. All but six of the 534 SIDS cases reported during the study period could be mapped precisely within counties and were used in the calculation of SIDS incidence rates per thousand live births for each of the reporting counties.

births. Because of this difference in rates, the number of SIDS cases observed in the subregion was considerably below what would have been expected had the average state rate applied in this subregion. The number of expected SIDS cases came much closer to the number of cases observed after the number of expected cases was adjusted to reflect the white and nonwhite proportions of the live births that were certified in this subregion (Table 3). It should be noted that the relatively remote Appalachian subregion is inhabited predominantly by whites, and whites had conspicuously lower SIDS rates throughout the state than did either blacks or Indians.

The Piedmont subregion is centrally located in the state and it is the most populous. This subregion has the largest cities and its white and nonwhite populations are in the approximate proportions to their respective shares of the state's total population. The Piedmont's SIDS rate was 2.04 per thousand live births, which was very close to the average state rate of 2.06 per thousand live births. The number of SIDS cases reported and the numbers expected were very nearly the same (Table 3).

The Coastal Plain subregion has more of a rural character than the Piedmont and its major cities are not as large and are more widely separated than those of the Piedmont. The nonwhite proportion of the Coastal Plain population is higher than for either of the other subregions. This subregion also had the highest SIDS rate, of 2.34 per thousand live births. Within this subregion, however, there was a considerable range. Among the northeastern counties there were seven that did not report SIDS cases, and a number of others in this same area had below average rates. Close to the border with South Carolina, there is a cluster of counties which had some of the highest SIDS rates encountered in the state (Figure 1). These counties coincide well with the distribution of Lumbee Indians in the state.

White and Nonwhite SIDS Rates Compared by Counties

The average state SIDS rate for nonwhites was three times higher than it was for whites during the period studied. It became apparent that this relationship was persistent when SIDS rates were calculated separately for whites and nonwhites in all the reporting counties.

Of the 81 counties that reported cases: 57 counties reported white cases, 67 counties reported nonwhite cases, and 43 reported both white and nonwhite cases. The calculation of white SIDS rates by counties yielded a range in rates from zero to a high of 4.4 per thousand live births. There were counties which had nonwhite incidence rates of zero, but there were also 19 counties with nonwhite SIDS rates of over 5.0 per thousand live births. In addition there were five counties where the nonwhite SIDS rates were higher than 10.0 per thousand live births. In four of these five cases, however, the nonwhite live birth denominator population was rather small and there were only one or two reported cases.

SIDS Rates for Counties with Similar Settlement Characteristics

North Carolina's counties vary considerably in their settlement characteristics, with some counties being exclusively rural and others being predominantly urban. When the state's counties were ranked into three groups according to settlement characteristics, it appeared that the presence or absence of cities had some bearing upon the SIDS rates reported. (Table 4).

During the course of mapping the locations of individual SIDS cases in the 36 more highly urbanized counties it be-

TABLE 3—Population Characteristics, SIDS Rates, and the Numbers of SIDS Cases by State Subregions

	Appalachian Mountains	Piedmont	Coastal Plain
Number of Counties	25	34	41
Share of the State's Population	16%	53%	31%
Nonwhite Proportion of the Population	5.5%	21%	32%
Subregions SIDS Rate per 1,000 Live Births	1.40	2.04	2.34
Number of SIDS Cases Reported	50	263	221
Number of SIDS Cases Expected at the Average State Rate of 2.06 Per 1,000 Live Births	73	265	194
Number of SIDS Cases Expected After Applying White and Nonwhite SIDS Rates to Their Respective Shares of the Total Subregional Live Births	55	260	217

TABLE 4—SIDS Rates per 1,000 Live Births for Groupings of North Carolina Counties with Similar Settlement Characteristics: Three-Year Summary 1972, 1973, and 1974

No. of Counties	Settlement Characteristics	Combined SIDS Rate	White SIDS Rate	Nonwhite SIDS Rate
36	Counties which had cities with populations of over 10,000 people	2.1*	1.2	3.9
30	Counties which had cities with populations less than 10,000 people	2.0*	1.1	3.8
34	All exclusively rural counties	1.7*	1.2	2.7
20	Exclusively rural counties which reported SIDS cases	2.7	1.8	5.0

*The null hypothesis of an even distribution of SIDS cases in the proportion of live births occurring in the three categories of counties classed by settlement characteristics was not rejected.
($X^2 = 1.4$, D.F. = 2, $P < 0.10$)

came apparent that more cases were occurring in the larger cities than in other parts of the counties that contained the cities. There were 38 cities with populations of over 10,000 people distributed among the 36 counties. The cities accounted for 39.5 per cent of the live births occurring in the 36 counties; however, they also accounted for 52 per cent of the SIDS cases reported in the same counties. The SIDS rates of the individual cities were commonly observed to be considerably higher than those of the suburban and rural portions of the counties in this category.

SIDS in North Carolina Cities

North Carolina's 1974 population is estimated to have been approximately 47.2 per cent urban. Of the total number of SIDS cases reported, 48.7 per cent were found to have occurred in urban locations. From these figures there was no indication that infants in any urban area were at greater risk from SIDS than those in rural areas. When SIDS rates were calculated for individual cities it was found that there was a sizeable range in the rates.

The average SIDS rate for cities with populations of over 10,000 was 2.8 per thousand live births. For whites in these cities the average SIDS rate was 1.8 per thousand live births and for nonwhites it was 4.1 per thousand live births. The range in SIDS rates for these cities was from zero to a high of 10.6 per thousand live births. White urban SIDS rates, when calculated separately, revealed a range of from zero to a high of 6.2 per thousand live births. For nonwhites the urban SIDS rates ranged from zero to a high of 19.6 per thousand live births.

A number of cities in certain size classes and certain locations were observed to have rather similar SIDS rates. When the cities were grouped by size classes and SIDS rates were calculated, it appeared that the largest and the smallest cities tended to have the lowest urban SIDS rates (Table 4).

Socioeconomic Conditions and SIDS

It has been commonly reported that SIDS incidence rates are higher among socioeconomically disadvantaged groups. In North Carolina, data on the socioeconomic circumstances of SIDS families are being collected by the public health nurses of the North Carolina SIDS Project. Normally, two to three family visits are made over a period of six months, and data are collected at each home visit to families who agree to participate in the study. A problem encountered which has made complete data collection difficult is that families may move or refuse to participate after the initial visits have been made. During the first 18 months of the North Carolina SIDS Project's operation, beginning on January 1, 1975, 209 confirmed SIDS cases occurred. Of this number, seven were from out-of-state and no follow-up was made for these cases. Of the remaining 202 cases, 34 families could not be located because they had moved. Of the 202 eligible cases, contacts were made with 168 families, and 15 of that number refused to participate in the study. Home visits were made to 153 SIDS families and social and economic data were collected. Before the second visits to these families, approximately 20 families had moved and could not be contacted again. For 148 families visited at least once, enough data were collected to permit the calculation of a social position score based upon the years of education completed by, and the income levels of the heads-of-households[6] (Table 6). Nearly two-thirds of the SIDS families visited by the North Carolina SIDS Project nurses were in the lowest socioeconomic rank, and there is no reason to suspect that the distribution of SIDS cases by family social position scores would have been any different between 1972 and 1974.

In North Carolina there are considerable disparities between the social and economic circumstances of the state's counties and cities. Most commonly, the counties which post the highest general infant mortality rates are by most measures also considered to be less well off socioeconomically. During the course of the SIDS case mapping it was observed that counties known for their concentrations of

TABLE 5—North Carolina Urban SIDS Rates per 1,000 Live Births by City Size Classes: Three-Year Summary 1972, 1973, and 1974

No. of Cities	City Sizes	Combined SIDS Rate	White SIDS Rate	Nonwhite SIDS Rate
5	Over 100,000	1.9**	0.9	3.1
4	50,000-99,999	4.0**	3.7	4.5
7	25,000-49,999	2.8**	1.5	4.6
12	15,000-24,999	4.4**	2.5	7.9
9	10,000-14,999	2.0**	1.7	2.5
—	* 2,500-9,999	1.4	—	—

*The infant population at risk in cities with less than 10,000 people was interpolated from the percentage of county populations classed as urban in 1970.

**The null hypothesis of an even distribution of SIDS cases among large cities in the proportions of the live births of the cities was rejected. ($X^2 = 30.27$, D.F. = 4, $P < 0.001$)

TABLE 6—Social Position Scores of SIDS Families in North Carolina*

Social Rankings	Social Position Score	Number of SIDS Cases	Percentages of All Cases
Highest	1	3	2
	2	1	1
	3	13	8
	4	35	24
Lowest	5	96	65
Total SIDS families scored by social position		148	100
Total cases		209	
Out-of-state cases		7	
Eligible cases		202	
Unable to contact		34	
Refused to participate		15	
Families participating		153	

*The Hollingshead two factor index of social position was used in the North Carolina study. It is based upon the years of education completed by and the incomes of the heads-of-households. Data in this table were provided by Ruth Ann Yauger, coordinator of the North Carolina SIDS Project.

poverty, and for having higher general infant mortality rates, also tended to have higher than state average SIDS rates. An attempt was made to correlate the observed SIDS rates of both cities and counties with their general infant mortality rates, and these tests proved significant. One would expect some correlation to be present between these variables in that the SIDS cases reported during the three-year period made up approximately ten per cent of the general infant mortality during the same period. What was not clear was whether or not SIDS rates increased with any consistency among the cities and counties as general infant mortality rates were observed to be higher.

The correlation between the SIDS rates observed in the 38 largest cities of the state and the general infant mortality rates of those cities was statistically significant ($r = 0.33$; $p = 0.02$). The correlation between the SIDS rates and the general infant mortality rates for the state's 100 counties was also statistically significant ($r = 0.24$; $p = 0.009$).

Conclusions

The differences observed between the SIDS rates of the generalized subregions were primarily the result of the uneven distribution of the nonwhite population. Nonwhite SIDS rates were about three times higher than those of whites, with the result that although nonwhites accounted for only 31 per cent of the live births in the state during the study period, they also accounted for 53.7 per cent of all the SIDS cases reported. It was also noted that the counties with significant minorities of Indians had among the highest SIDS rates in the state.

On the balance, the proportion of SIDS cases occurring in urban locations statewide almost matched the percentage of the state's population that was estimated to have been urban in 1974. At this level of generalization two distinctive findings were obscured: namely, that the largest and the smallest cities tended to have the lowest urban SIDS rates, and that SIDS cases were also reported more often within the limits of the largest cities than in the suburban or rural portions of the counties in which these cities were located.

The correlations made between the observed SIDS rates and general infant mortality rates, although not entirely unexpected, are of considerable interest. In North Carolina, at least, the existence of a higher than average general infant mortality rate may likely be taken as an indication that a higher than average SIDS rate is also present.

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Nursing Research Forum Set for May

The Second Annual Nursing Research Forum of the College of Nursing, University of Illinois, will be held May 8, 1978. The all day program will consist of presentations and discussion of research by undergraduate and graduate students and faculty. Continuing education credit is being applied for and a small fee will be charged to cover the cost of coffee and printing of the program and abstracts. Registration information is available from Ms. M. De Maire, College of Nursing, University of Illinois, 845 S. Damen Avenue, Chicago, IL 60612.